

# **CHAPTER 17**

## **Drip Dispersal**

### **On-Site Decentralized Wastewater Treatment Systems**

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## DRIP DISPERSAL TREATMENT

### 17.1 General

#### 17.1.1 General

This chapter provides guidelines and criteria for the design of drip dispersal systems for treated domestic wastewater with a 5-day biochemical oxygen demand (BOD<sub>5</sub>) of 30 mg/L or less. It is not applicable to spray irrigation, overland flow or rapid infiltration.

#### 17.1.2 Applicability

Drip dispersal systems are designed and operated to allow the soil to provide final treatment of the wastewater prior to its introduction to groundwater and so that there is no direct discharge to surface waters. Dispersal and treatment occurs via physical, chemical and biological processes within the soil and through evapotranspiration and nutrient uptake by plant matter.

The infiltrative capacity of soil is a critical factor to be considered when designing any type of subsurface sewage disposal system. However, equal consideration must be given to other factors that control the overall lateral movement of groundwater within the soil profile. Considering the analogy of a bathtub, the amount of water entering the tub cannot exceed the amount of water exiting the tub without eventually overflowing. The same logic applies to areas of soil being considered for drip dispersal of treated sewage effluent.

If the profile of a particular soil considered for drip dispersal extended to a significant depth without a restrictive horizon, the ability to load that soil per unit area would be relatively high. On the other extreme, if a soil being considered for drip dispersal had a shallow restrictive horizon, the ability to load that soil would be significantly limited. Depth to restrictive horizon, soil permeability and slope of the restrictive horizon are factors that control the amount and rate at which ground water can exit an area. If the amount of treated effluent applied to an area, in combination with rainfall over the area and groundwater moving into the area, exceed the soil profile's ability to transmit the water away from the application area, surface expression of liquid will occur.

Evaluation of a soil area's suitability for drip dispersal must take into consideration limiting aspects of the soil profile. Level sites with shallow restrictive horizons overlain by low permeability soils represent one of the more limited scenarios for drip dispersal and the application rate and/or application area must be suitably modified. Studies conducted by Dr. Jerry Tyler (University of Wisconsin) provide a more quantitative assessment of the role these criteria play.

Also critical when designing systems in soils with shallow restrictive horizons are the presence and location of hydrologic boundaries such as drains and waterways. These hydrologic boundaries provide an outlet for ground water discharge. Not only is it critical to identify these features in consideration of appropriate setbacks/buffers, it is also critical to factor in their role in the overall hydrologic cycle of the physical setting.

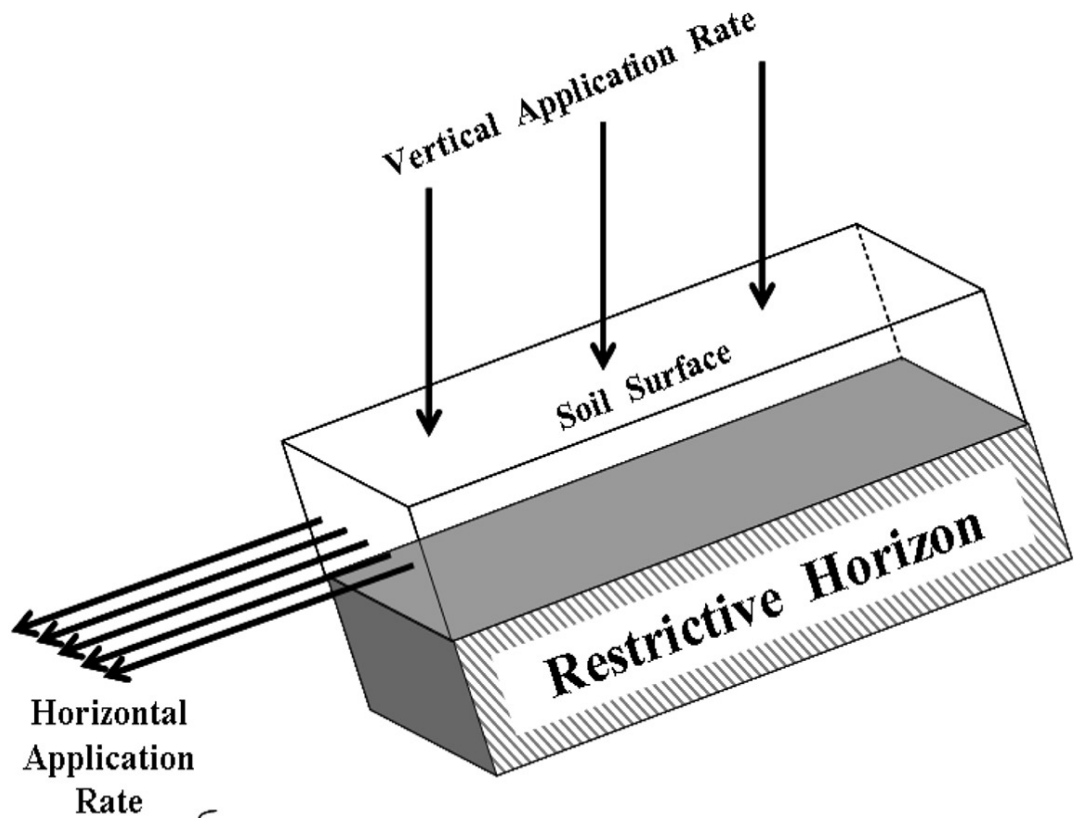
Horizons along which lateral flow would be expected include, but are not necessarily limited to: bedrock, fragipans, and zones with high clay percentage overlain by more permeable soil.

**Drip dispersal design submittals must take into consideration all factors influencing the infiltrative capacity of the soil and the ability of the soil profile to transport ground water away from the application area.**

#### 17.1.3 Slopes and Buffers

**Slopes.** Land application areas with slopes greater than 50 percent will not be approved. Slopes with suitable soils may be used for drip dispersal at up to and including 50% slope. Depending upon the shape of the slope (concave, convex or linear) the design engineer may have to make adjustments in the aspect ratio of the drip lines on the slope, the loading rate, or both to ensure that all applied effluent will move down gradient and/or into the underlying formations without surfacing. It is important to note that when the proposed drip field area slopes are greater than 30% and the soil textures are predominantly granular, a geologic investigation shall be conducted by a geologist or geological engineer evaluating the slip potential of the slope under operating conditions. When slopes increase above 10 percent, wastewater flow down the slope (parallel to the slope) may control the hydraulic design of the system. For land application areas with slopes between 10 percent and 50 percent, the length to width ratio (L:W) must ensure that the horizontal wastewater application rate in the down slope direction does not exceed twenty (20) times the vertical application rate (see Figure 17.1).

FIGURE 17.1



{ For slopes greater than 10% the Horizontal Application Rate must not exceed twenty (20) times the Vertical Application Rate }

The design engineer must perform a landscape loading rate analysis to determine the saturation depth at design load and flow of the most restrictive cross-section in the down gradient flow path within and beyond the drip field. The aspect of ratio of the drip lines must be adjusted or the loading rate reduced as necessary to ensure that surfacing does not occur.

**Buffers.** The location of the septic tank, dosing chamber and disposal field shall be selected in accordance with **Table 17-1**. It is important to note that site conditions may require increased distances of separation. The distances may increase as soil conditions so warrant as determined by a soil scientist. In any event, the soil scientist must provide a certification statement detailing the rationale used for his recommended site buffers.

**TABLE 17-1**

<b>Site Feature</b>	<b>Buffer Distance</b>	
	<b>Septic Tank and/or Dosing Chamber (Feet)</b>	<b>Dispersal Field (Feet)</b>
<b>Wells and Springs</b>	<b>50</b>	<b>100</b>
<b>Dwellings and Buildings</b>	<b>5</b>	<b>10</b>
<b>Property Lines</b>	<b>10</b>	<b>10</b>
<b>Underground Utilities</b>	<b>10</b>	<b>10</b>
<b>Septic Tank</b>	<b>NA</b>	<b>5</b>
<b>Gullies, Ravines, Blue Line Streams, Drains Drainways, Cutbanks, and Sinkholes</b>	<b>50</b>	<b>50</b>
<b>Closed Depressions</b>	<b>*</b>	<b>*</b>
<b>Soil Improvement Practice</b>	<b>25</b>	<b>25</b>

\*To be determined by the design engineer and approved by the Division of Ground Water Protection.

#### 17.1.4 Soils

In general, moderately permeable and well-drained soils are desirable. However, the use of any soil is acceptable if it meets the following two (2) criteria:

1. The applied effluent loading rate does not exceed the applicable hydraulic loading rate in **Table 17-2**. The applicable hydraulic loading rate is determined by a detailed site evaluation in which the site is gridded, bored, and mapped with pits to determine the texture and structure of each soil type.
2. The applied effluent maximum loading rate does not exceed 10% of the minimum NRCS saturated vertical hydraulic conductivity for the soil series or 0.25 GPD/SF whichever is least.

**TABLE 17-2**

Hydraulic Loading Rates (GPD/SF) – For Drip Dispersal Systems

TEXTURE	STRUCTURE		HYDRAULIC LOADING RATE GPD / SF BOD ≤ 30 mg/L
	SHAPE	GRADE	
Coarse Sand, Loamy Coarse Sand	NA	NA	NA*
Sand	NA	NA	NA*
Loamy Sand, Fine Sand, Loamy Fine Sand, Very Fine Sand, Loamy Very Fine Sand	Single Grain	Moderate, Strong	0.50
		Massive, Weak	0.40
Coarse Sandy Loam, Sandy Loam	Massive	Structureless	0.30
	Platy Prismatic Blocky, Granular	Weak	
		Moderate, Strong	
		Weak	0.40
Loam	Prismatic Blocky, Granular	Moderate, Strong	0.50
		Massive	Structureless
		Weak, Moderate, Strong	
		Weak	0.30
Silt Loam	Prismatic, Blocky, Granular	Moderate, Strong	0.40
		Massive	Structureless
		Weak, Moderate, Strong	
		Weak	0.20
Sandy Clay Loam, Clay Loam, Silty Clay Loam	Prismatic, Blocky Granular	Moderate, Strong	0.30
		Massive	Structureless
		Weak, Moderate, Strong	
		Weak	0.15
Sandy Clay Clay, Silty Clay	Prismatic, Blocky, Granular, Subangular	Moderate, Strong	0.20
		Massive	Structureless
		Weak, Moderate, Strong	
		Weak	0.075
		Moderate, Strong	0.10

\* Requires a special site investigation



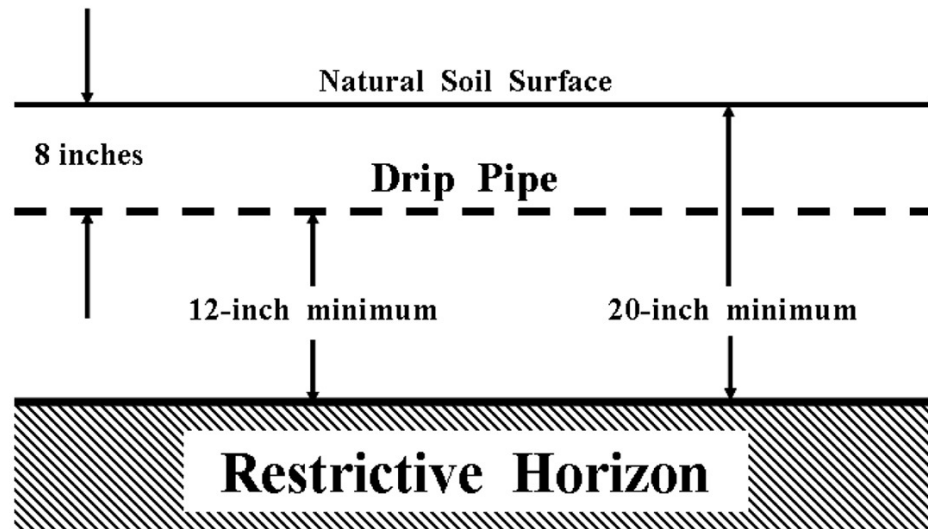
Drip dispersal is not allowed in soils with these characteristics

*Compiled from: EPA, Netafim, GeoFlow, AL, NC, MS, GA, TX, AR and TN*

It is desirable for the soil to have a minimum depth of twenty (20) inches of undisturbed soil above a restrictive horizon (rock or fragipan) to provide an eight (8) inch installation depth and a twelve (12) inch buffer below the drip line. (See **Figure 17.2**) Loading rates may need to be decreased where the soil permeability is moderately slow or slower and there is insufficient slope to move the applied effluent away from the site.

**FIGURE 17.2**

### **Natural Soil Conditions**



Even if a soil meets the depth requirements it may not be suitable due to the texture and/or structure. If a soil should show signs of wetness within a depth of 20 inches of the soil surface, it will require a soil improvement practice such as an interceptor or drawdown drain (any such improvement practice will require a certification statement from a soil scientist). Therefore, internal drainage may be necessary and must be discussed by the soil scientist in their certification statement with explanation of other soil improvements where drains are necessary to protect the integrity of the drip dispersal area. The location and size of the drains and buffers must be factored into the total area required for the drip dispersal system.

If a soil should exhibit anaerobic conditions within 20 inches of the soil surface, it will be considered unsuitable and not eligible for consideration.

**In order to ensure even distribution of the wastewater and maximum utilization of the soil, the emitter lines shall be placed on two (2) foot centers with a two (2) foot emitter spacing such that each emitter supplies a four (4) square foot area.** These lines are best placed at depths of six (6) to ten (10) inches below the surface. The drip lines shall be laid level and shall run with the contour. Closer line and emitter spacing of twelve (12) inches will be required for heavy

clay soils or very coarse sands where lateral movement of water is restricted. Using closer spacing must not reduce the size of the drip dispersal area.

## 17.2 Soil Investigations

### 17.2.1 General

The proposed drip dispersal area is to be mapped at sufficient accuracy to identify each soils series present and the boundary location between series. Mapping should be of such purity that there are less than 10% of dissimilar soils within a soil unit. Preliminary soil investigations should be done to identify areas best suited for wastewater dispersal. Once those areas are identified, the more detailed procedures outlined below should be employed.

### 17.2.2 Soil Mapping

The mapping procedure will usually begin with the property/land being generally evaluated to delineate or separate areas with suitable characteristics. This procedure will save time and money since some areas will be too shallow, too wet, too steep, etc. Once a suitable area(s) is established and marked the area should be grid staked at fifty (50) foot centers and surveyed. Adequate ground control is mandatory for each site. The ground control is necessary to reproduce the map if needed. All located coordinates must be shown on the final soils map.

The soil scientist is responsible for conducting a sufficient number of borings that, in his professional opinion, will allow him to certify the soils series present, identify boundaries between series, and describe each soil horizon as to structure, texture, color, depth to restrictive horizon, and depth to rock. Any redoxymorphic features observed are to be described. Using the soil data, the soil scientist shall delineate the suitable soils from the non-suitable soils. This delineation shall be based upon the texture and structure of the soils to a depth of thirty-six inches or to rock or R horizon whichever is shallower.

After a suitable soils area is established and marked, a soil boring to a minimum depth of forty-eight (48) inches or rock or fragipan, whichever is shallowest, must be taken at each grid point inside the suitable area. The exact number and location of borings may be reduced as stipulated by a soil scientist employed by the Division of Ground Water Protection (GWP). The soils boring data shall be entered onto a log sheet and submitted with the soils map, engineering report and State Operations Permit (SOP) application. Unless otherwise determined by the GWP soil scientist, two (2) soil pits per acre for each suitable map unit shall be opened and the soil described to a depth of thirty-six inches or to rock or a fragipan, whichever is shallower. The description must be entered onto a pedon sheet and submitted with the soils map and engineering report. If a



unit does not fit a particular soil profile, the soil scientist is encouraged to use the soils name or combination of names that best fits the observed profile. The soil backhoe pits should be located, numbered and shown on the plat.

A detailed soils map (minimum requirement is an extra-high intensity map) with two-foot contour intervals is required for each area to be used for drip dispersal. The map shall identify each soil series present and shall describe the soil horizons to a minimum depth of thirty-six (36) inches or to the R horizon, whichever is shallower. The number of auger borings sufficient to define the boundaries of each soil series shall be determined by the soil scientist. In their description of soil horizons, the soil scientist shall describe, via pits, the structure, texture, color, and any redoxymorphic features present. They should also describe root depth and presence of wormholes, macropores, etc. The soil scientist shall also identify the depth to hard rock using an auger or a tile probe if the depth is less than 48 inches and estimate same if greater than forty-eight (48) inches. The soil scientist will be required to prepare and sign a detailed certification statement for each site evaluated.

Grid staking is done in the form of an extra-high intensity soil map and shall be provided for each area to be evaluated for wastewater dispersal. Each soil map unit proposed for drip dispersal must be described by a soil profile determined by a pit which shall be at least thirty-six (36) inches wide by thirty-six (36) inches deep.

The mapping procedure must also include, at a **minimum**, auger borings at 100-foot intervals (i.e., within every other grid) to 48-inch depth or refusal. The soil map must show grid points, locations of bore holes, probe holes and/or pits, soil map units, rock outcroppings and soil unit legend. Either on the map, or a separate attached document, the following data must be provided on each auger bore hole: horizons, texture, mottling and depth to restrictive most limiting horizon.

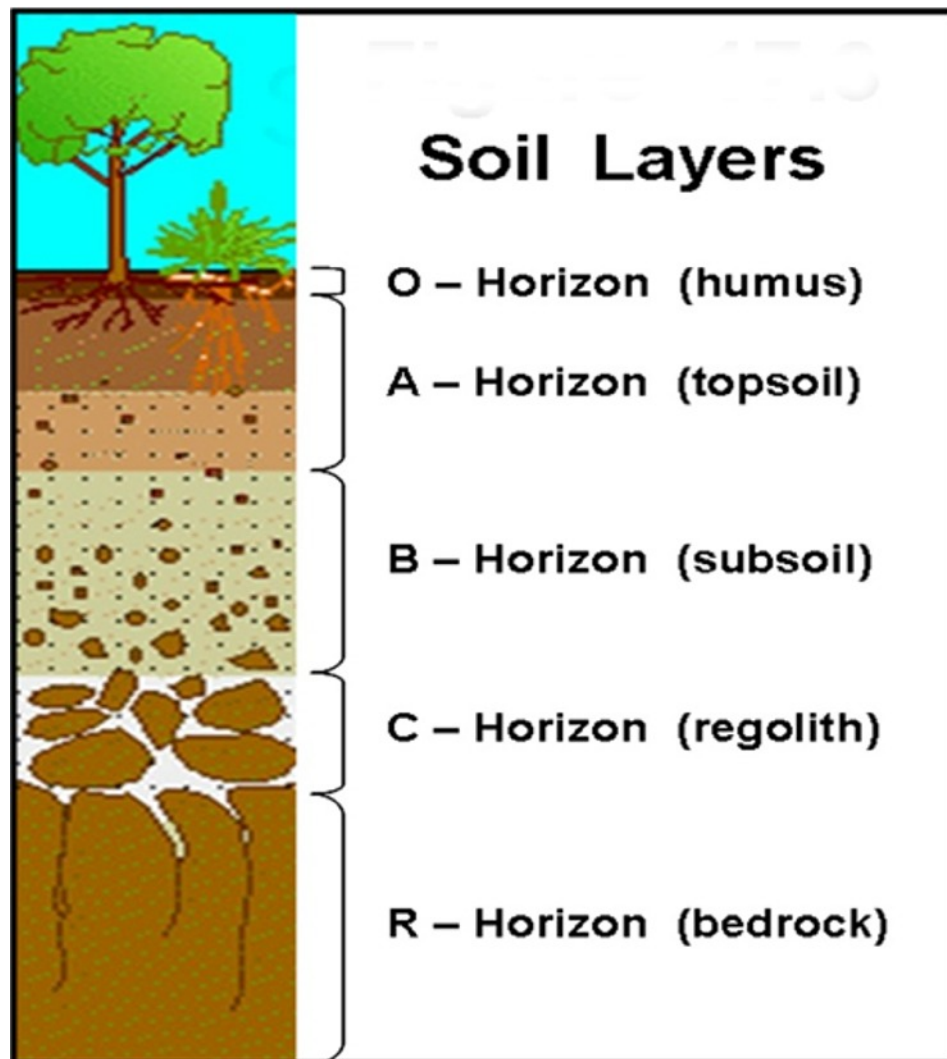
Soils maps for drip dispersal areas will not contain Minutes Per Inch (MPI) ratings as these ratings are more or less specific to the ability of soils to accept and move septic tank effluent. Significant conservatism has been built into these ratings over the years to attempt to account for the development of the clogging mat and the general inability to accurately describe the hydraulic conductivity of that mat. The soil scientist may, at his discretion, include in the soils description a reference to the Natural Resources Conservation Service (NRCS) hydraulic conductivity (permeability) rating for the series.

#### 17.2.3 Definitions:

**Soil Horizons (layers):** Soil is made up of distinct horizontal layers; these layers are called horizons and display vertical zones. They range from rich, organic upper layers (humus and topsoil) to underlying rocky layers (subsoil, regolith and bedrock).

Soil horizons develop due to the nature of soil formation. Soil is the product of the weathering of parent material (i.e. bedrock), accompanied by the addition of organic matter. The method for naming the soil horizons is quite simple as the **Figure 17.3** shows. In the simplest naming system, soils horizons are designated **O** (organic), **A** (topsoil), **B** (mineral soil), **C** (weathered parent material), and **R** is the unweathered rock (bedrock) layer that is beneath all the other layers. The horizons of most importance to plant growth and forest health are the **O** and **A horizons**. The **litter layer** found covering the soil is also of interest because it provides most of the organic matter found in the O and A horizons.

**FIGURE 17.3**



The **Litter Layer** is the topmost layer on the forest floor. It consists of leaves, needles and other non-decomposed material on the forest floor. While this is not considered part of the soil, it is interesting to measure the depth of the litter layer when sampling the soil. The depth of the litter layer can vary greatly even within a particular site. Because of this,

several measurements are required to attempt to characterize litter layer depth. The litter layer can be considered part of the overall soils depth.

The **O-Horizon** primarily consists of decomposed organic matter and has a dark rich color, increased porosity, and increased aggregate structure (larger soil “clumps”). The depth of the O horizon is measured from the surface of the soil (after the litter layer has been cleared away) to the point where the darker organic color changes to a slightly lighter colored soil that contains increased mineral particles in addition to organic matter. The transition from the O to the A horizon can also be recognized by a significant increase in the mineral soil particles. In many urban soils, the O horizon may very thin if it exists at all. The O horizon can also be considered part of the overall soils depth.

The **A-Horizon** is the **mineral** “topsoil” and consists of highly weathered **parent material** (rocks), which is somewhat lighter in color than the O horizon due to a decrease in **organic matter**. The particles in the A horizon are more granular and “crumb-like”. Seeds germinate and plant roots grow in this layer. It is made up of humus (decomposed organic matter) mixed with mineral particles. The depth of the A horizon is measured from the region of color changes from the dark O horizon to the transition to the B horizon. The transition to the B horizon can be identified by increased clay content (see below) and the absence of organic material: no root hairs, small pieces of needle, etc.

The most thorough soil study involves analysis on separate O and A horizon samples. This requires separating and storing O and A horizon samples. It also involves completing the entire soil analysis on both the O and A samples. If this is not possible, the O and A samples can be combined (or composited) and the analysis can be completed on the O and A sample together.

The **B-Horizon** is also called the **subsoil** - this layer is beneath the A horizon and above the C horizon. It contains clay and mineral deposits (like iron, aluminum oxides, and calcium carbonate) that it receives when soil solution containing dissolved minerals drips from the soil above.

The B horizon is identified by increased clay content which makes the soil hold together when moist. A simple test for clay content is to moisten a small handful of soil and attempt to smear a small portion up the forefinger. Soils high in clay will hold together and form a “ribbon”, soils with more sand and silt will be granular and fall apart. It is lighter in color and often may be reddish due to the iron content.

The **C Horizon** (layer beneath the B Horizon) consists of porous rock (broken-up bedrock, bedrock with holes). It is also called regolith or **saprolite** which means "rotten rock." Plant roots do not penetrate into this layer; very little organic material is found in this layer.

The **R-Horizon** is the unweathered rock (bedrock) layer that is beneath all the other layers. For the purposes of drip dispersal designs, the R horizon is considered an impermeable layer.

**High Intensity Soils Map.** A first order survey as defined in the Soil Survey Manual, United States Department of Agriculture, October 1993. These surveys are made for various land use that requires detailed soils information. Map units are mostly soil series, phase of soil series with some complexes and miscellaneous land areas. Map scale shall be one (1) inch equals one hundred (100) feet. Minimum size delineation shall be six hundred and twenty-five (625) square feet.

**Extra-High Intensity Soils Map.** An extra-high intensity soils map is the same as a high intensity soils map except the scale may be one (1) inch equals fifty (50) feet. These maps have more cartographic detail than a high intensity soils map. The extra-high intensity soils map is essentially a special map that shows a very high degree of soil and landscape detail and must be accompanied by specific evaluations and recommendations. Area to be mapped shall be grid staked at a fifty (50) foot grid or a twenty-five (25) foot grid may be needed under certain circumstances. These maps shall be clearly marked or labeled as Extra High-Intensity Soils Map.

**Baseline mapping standards for extra-high intensity soil maps prepared in support of drip dispersal shall be in accordance with the current edition of "The Soil Handbook" prepared by the Division of Ground Water Protection.** Soil profile information and pit excavation, as described in these design criteria, are additional requirements deemed necessary to properly assess an area's suitability for drip dispersal."

**Soil map unit.** A unique collection of areas that have common soil characteristics and/or miscellaneous physical and chemical features.

**Most limiting horizon.** A horizon in the soil (bedrock or fragipan) that either provides the greatest impediment to or completely stops, the downward movement of liquids through the soil.

#### 17.2.4 Plat Requirements

A one hundred (100) feet master grid system with surveyed control stakes numbered and the location of each stake shown on a surveyed plat of the drip dispersal area must be provided to the soil consultant. The ground control stakes must be set no more than one hundred (100) feet apart. The ratio of precision of the unadjusted survey shall be a minimum of 1:1000. The plat shall show the seal and signature of the surveyor and show a bar scale. The removal of vegetative growth such as weeds, vines and briars may be required. All grid stakes must be maintained until the project's engineering report and SOP application is approved by the Tennessee Department of Environment and Conservation (a joint effort by the Divisions of Water Pollution Control and Ground Water Protection).

#### 17.2.5 Special Soil/Geologic Considerations

For sites with slopes between 30% and 50%, a special investigation (performed by a qualified professional, such as a geologist, geo-tech engineer, engineering geologist, etc.) shall be conducted to evaluate those sites. To adequately complete these determinations the following information must be provided.

- Dip and strike angle of underlying bedrock
- Depth to either hard rock and partly weathered rock
- Type of rock (limestone, shale, etc)
- Soil particle-size class designation to a depth of six (6) feet or to hard rock whichever is more shallow
- Slippage potential of slope
- Certification statement signed by a qualified professional that addresses all of the above characteristics.

For sites with slopes between 30% and 50%, in addition to meeting all other soil suitability requirements, the site must also meet the following requirements:

- Have a vertical depth of at least twenty-four (24) inches of soil above the rock layer.
- Not have a particle size class of fragmental or sandy-skeletal.

### 17.3 Determination of Design Application Rates

#### 17.3.1 General

One of the key steps in the design of a drip dispersal system is to develop a "design application rate" in gallons per day per square foot (GPD/SF). This value is derived from either the hydraulic (water) loading rate (L<sub>wh</sub>) based upon the texture and structure of the soils and/or nutrient (nitrogen) loading rate (L<sub>wn</sub>) calculations to determine design wastewater loading(s) and, thus, drip field area requirements.

#### 17.3.2 Design Values

The most limiting layer; i.e., A, B or C horizon, of each soil series must be identified. Any surface conditions which limit the vertical or lateral drainage of the soil profile must also be identified. Examples of such conditions are shallow bedrock, a high water table, aquitards, and extremely anisotropic soil permeability. Design considerations relative to the soils per Section 17.1.4 must be used.

Values of saturated vertical hydraulic conductivity must be modified by an appropriate safety factor to determine design percolation. The safety factor reflects the influence of several elements including: the fact that long periods of saturation are undesirable, the uncertainty of test values, the drainage characteristics of the land treatment site, the variation of permeability within and between different soil series, the rooting habits of

the vegetation, the soil reaeration factors, and the long term changes in soil permeability due to wastewater application

Sites with seasonal high groundwater less than twenty-four (24) inches deep may require drainage improvements before they can be utilized for slow rate land treatment. The design percolation at such sites is a function of the design of the drainage system.

## 17.4 Determination of Design Wastewater Loading

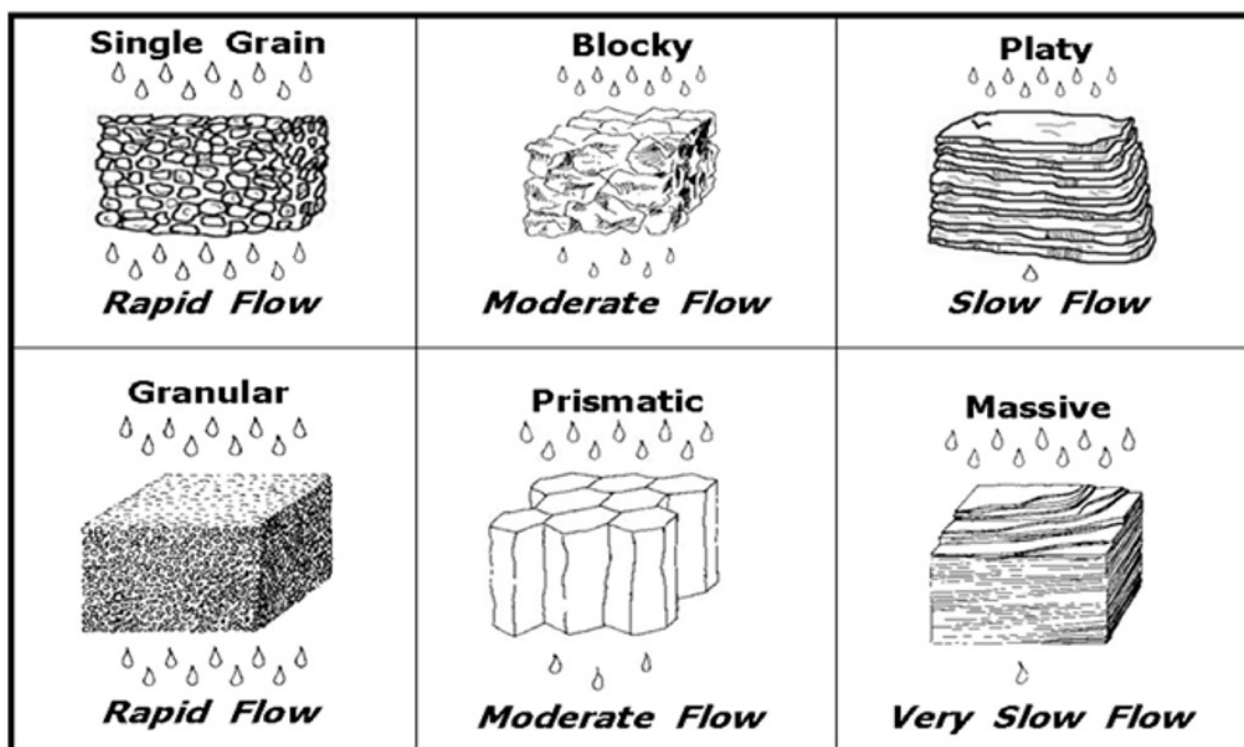
### 17.4.1 General

The design wastewater loading is a function of:

- a. Precipitation.
- b. Evapotranspiration.
- c. Design percolation rate.
- d. Nitrogen loading limitations.
- e. Other constituent loading limitations.
- f. Groundwater and drainage conditions.
- g. Average and peak design wastewater flows.
- h. Soil denitrification rates
- i. Rate of nitrogen uptake in site vegetation

Therefore, developing the design wastewater loading is an iterative process. The L<sub>wh</sub> value is determined by a detailed site evaluation and will be dependent upon the soil characteristics as shown in Table 17-2 and pictorially represented in **Figure 17.4**. This loading is then compared to the L<sub>wn</sub> loading limitations (reference Section 17.5). If the initial L<sub>wh</sub> value exceeds the L<sub>wn</sub> value, the design wastewater loading resulting from the nitrogen reduction evaluation described in Section 17.5 becomes the design loading rate.

### **FIGURE 17.4**



## 17.5 Nitrogen Loading and Crop Selection and Management

### 17.5.1 General

Nitrate concentration in percolate from wastewater irrigation systems must not exceed 10 mg/L nitrate-nitrogen at the site property line. Percolate nitrate concentration is a function of nitrogen loading, cover crop, and management of vegetation and hydraulic loading. The design wastewater loading determined from using the criteria stipulated in 17.1.4 for hydraulic conductivity must be checked against nitrogen loading limitations. If, for the selected cover crop and management scheme, the proposed wastewater loading results in estimated percolate nitrate concentrations exceeding 10 mg/L, either the loading must be reduced or a cover crop and management plan providing a higher nitrogen uptake must be selected.

### 17.5.2 Nitrogen Loading

In some instances, the amount of wastewater that can be applied to a site may be limited by the amount of nitrogen in the wastewater. A particular site may be limited by the nitrogen content of the wastewater during certain months of the year and limited by the infiltration rate during the remainder of the year.

Equation 17-2 is used to calculate, on a monthly basis, the allowable hydraulic loading rate based on nitrogen limits:

$$L_{wn} = \frac{C_p (Pr - PET) + U(4.424)}{(1 - f)(C_n) - C_p} \quad (\text{Equation 17-2})$$

Where: <b>L<sub>wn</sub></b>	=	allowable monthly hydraulic loading rate based on nitrogen limits, inches/month
<b>C<sub>p</sub></b>	=	nitrogen concentration in the percolating wastewater, mg/L. This will usually be 10mg/L Nitrate-Nitrogen
<b>P<sub>r</sub></b>	=	Five-year return monthly precipitation, inches/month
<b>PET</b>	=	potential evapotranspiration, inches/month
<b>U</b>	=	nitrogen uptake by cover, lbs/acre/year pounds/acre/year
<b>C<sub>n</sub></b>	=	Nitrate-Nitrogen concentration in applied wastewater, mg/L (after losses in preapplication treatment)
<b>f</b>	=	fraction of applied nitrogen removed by denitrification and volatilization.

The values of  $L_{wh}$  and  $L_{wn}$  are compared for each month. The lesser of the two values will be used to determine the amount of acreage needed.

**NOTES:**

- A “**C<sub>n</sub>**” value of less than 25 mg/L will become a permit condition.
- The allowable vegetative uptake “**U**” of nitrogen on the drip area will be limited to an uptake rate of 50 pounds per acre per year unless trees are the vegetation.
- The “**f**” values for denitrification have been estimated based upon data supplied by the University of Tennessee and Oak Ridge National Laboratory. Denitrification rates (f) ranging from 25% in January and February to 35% in July and August are very conservative, but are defensible based upon the literature. Denitrification rates are assumed to vary linearly with the temperature and the actual rates are likely to be higher than the default values shown in Table 17-2.

Table 17-3 shows the default values for  $L_{wn}$  calculations. Other values may be used provided adequate rationale and documentation is presented to, and approved by the Division of Water Pollution Control.



**TABLE 17-3**

<b>MONTH</b>	<b>Pr<sup>(1)</sup> Inches / Month</b>	<b>PET<sup>(2)</sup> Inches / Month</b>	<b>N Uptake<sup>(3)</sup> Percent / Month</b>	<b>f Denitrification<sup>(4)</sup> Percent / Month</b>
<b>JAN</b>	7.62	0.10	1%	25%
<b>FEB</b>	6.72	0.27	2%	25%
<b>MAR</b>	8.85	0.97	4%	27%
<b>APR</b>	6.59	2.30	8%	29%
<b>MAY</b>	6.13	3.59	12%	31%
<b>JUN</b>	5.52	4.90	15%	33%
<b>JUL</b>	6.85	5.44	17%	35%
<b>AUG</b>	4.73	5.00	15%	35%
<b>SEP</b>	5.54	3.79	12%	34%
<b>OCT</b>	4.47	1.98	8%	32%
<b>NOV</b>	6.11	0.82	4%	29%
<b>DEC</b>	7.55	0.27	2%	26%

(1) Based upon Table A-3 of Chapter 16 – 5-year return monthly precipitation

(2) Based upon Table A-2 of Chapter 16 – Potential Evapotranspiration

(3) Based upon Table A-5 of Chapter 16 – Monthly Nitrogen Uptake by Vegetation

(4) Applied Nitrogen Fraction Removed by Denitrification / Volatilization

**Note: Appendix 17-B shows examples illustrating the use of Equation 17-2.**

#### 17.6 Plan of Operation and Management

A Plan of Operation and Management (POM) is required before a State Operating Permit (SOP) can be issued. The POM is written by the owner or the owner's engineer during construction of the drip system. Once accepted by the Division of Water Pollution Control, the POM becomes the operating and monitoring manual for the facility. This manual must be kept at the facility site and must be available

for inspection by personnel from the Tennessee Department of Environment and Conservation.

This Plan should include, but not be limited to, the following information:

#### 17.6.1 Introduction

##### a. System Description:

1. A narrative description and process design summary for the land treatment facility including the design wastewater flow, design wastewater characteristics, preapplication treatment system and drip fields.
2. A map of the land treatment facility showing the preapplication treatment system, drip fields, buffer zones, roads, streams, drainage system discharges, monitoring wells, etc.
3. A map of force mains and pump stations tributary to the land treatment facility. Indicate their size and capacity.
4. A schematic and plan of the pre-application treatment system identifying all pumps, valves and process control points.
5. A schematic and plan of the irrigation distribution system identifying all pumps, valves, gauges, etc.

- ##### b. Discuss the design life of the facility and factors that may shorten its useful life. Include procedures or precautions which will compensate for these limitations.

#### 17.6.2 Fine Filtration

All drip dispersal systems must include a filter between the secondary treatment system and the disinfection unit and/or drip field to prevent introduction of sediments and suspended organic materials that could clog the drip tubing or that would interfere with disinfection. Without proper filtration, sediment can accumulate over time and cause plugging. A 100-130 micron disc filter is recommended. However, the designer must adhere to the recommendation of the drip line manufacturer.

The filter must also be equipped with a mechanism for automatic backwashing using pressurized, clean water (final effluent or potable water). If potable water is used, the backwash line must be equipped with a backflow prevention device.

For forward flush of the drip lines, the filtration system shall be capable of flushing each drip field or zone back to the pretreatment tank at a minimum fluid velocity of 1.0 feet per second (fps) unless otherwise specified by the manufacturer. Field flushing velocity must be measured at the distant end of the drip tube.

All filter flushing must be accomplished automatically. Back flushing of the filter must occur after each pump cycle or as recommended by the manufacturer if this

is not appropriate for the equipment. Forward flushing of each drip field or zone must occur at regular intervals, not to exceed 30 days.

#### 17.6.3 Vacuum Breakers and Pressure Compensating Emitters

Vacuum breakers must be placed at the highest elevation of a drip dispersal field or zone under protective cover and with grade level access.

All drip dispersal systems must be equipped with pressure compensating emitters to facilitate uniform distribution over the entire drip dispersal field or zone in such a manner to ensure that the discharge rate of any two (2) emitters must not vary by more than ten (10) percent.

#### 17.6.4 Management and Staffing

- a. Discuss management's responsibilities and duties.
- b. Discuss staffing requirements and duties:
  1. Describe the various job titles, number of positions, qualifications, experience, training, etc.
  2. Define the work hours, duties and responsibilities of each staff member.
  3. Describe the location of operational and maintenance personnel relative to the location of the treatment system.

#### 17.6.5 Facility Operation and Management

- a. Pre-application Treatment System:
  1. Describe how the system is to be operated.
  2. Discuss process control.
  2. Discuss maintenance schedules and procedures.
  4. Discuss the use of telemetry,
- b. Drip Dispersal System Management:
  1. Wastewater Application. Discuss how the following will be monitored and controlled. Include rate and loading limits.
    - (a) Wastewater loading rate (gallons per day per square foot or inches/week).
    - (b) Drip dispersal field application cycles
  2. Discuss how the system is to be operated and maintained.
    - (a) Storage pond(s), where utilized.
    - (b) Irrigation pump station(s)
    - (c) Drip dispersal field force main(s) and laterals
  3. Discuss start-up and shut-down procedures.

4. Discuss system maintenance.
  - (a) Equipment inspection schedules
  - (b) Equipment maintenance schedules
5. Discuss operating procedures for adverse conditions.
  - (a) Electrical and mechanical malfunctions
6. Provide troubleshooting procedures for common or expected problems.
7. Discuss the operation and maintenance of back-up, stand-by and support equipment.
- c. Drainage System (if applicable):
  1. Discuss operation and maintenance of surface drainage and runoff control structures.
  2. Discuss operation and maintenance of subsurface drainage systems.

#### 17.6.6 Monitoring Program

- a. Discuss sampling procedures, frequency, location and parameters for:
  1. Pre-application treatment system.
  2. Drip Dispersal System:
    - (a) Storage pond(s), where utilized
    - (b) Groundwater monitoring wells
    - (c) Drainage system discharges (if applicable)
    - (d) Surface water (if applicable)
- b. Discuss soil sampling and testing:
- c. Discuss ambient conditions monitoring:
  1. Rainfall
  2. Soil moisture
- d. Discuss the interpretation of monitoring results and facility operation:
  1. Pre-application treatment system.
  2. Drip dispersal fields.
  3. Soils.

#### 17.6.7 Records and Reports

- a. Discuss maintenance records:
  1. Preventive.
  2. Corrective.

- b. Monitoring reports and/or records should include:
  - 1. Pre-application treatment system and storage pond(s).
    - (a) Influent flow
    - (b) Influent and effluent wastewater characteristics
  - 2. Drip Dispersal System.
    - (a) Wastewater volume applied to drip dispersal fields.
    - (b) Loading rates.
  - 3. Groundwater Depth.
  - 4. Drainage system discharge parameters (if applicable).
  - 5. Soils data.
  - 6. Rainfall and climatic data.

## **APPENDIX 17 – A**

## APPENDIX 17-A

### Hydraulic Values and Conversion Factors

0.2 gallons per day per square foot (GPD/SF) = 2.25 inches per week (in/wk)

0.18 GPD/SF = 2.00 in/wk

0.13 GPD/SF = 1.5 in/wk

0.11 GPD/SF = 1.25 in/wk

0.10 GPD/SF = 1.12 in/wk

Moderately Slow Permeable @ 0.2 in/hr x 10% = 3.4 in/wk

Slow Permeable @ 0.06 in/hr x 10% = 1 in/wk

0.2 GPD/SF = 2.25 in/wk = 0.3214 in/day = 8,729 gallons per acre per day (gal/ac/day)

1 in/wk = 0.089 GPD/SF = 3,880 gal/ac/day

0.1 GPD/SF =  $4.7 \times 10^{-6}$  cm/sec

## **APPENDIX 17 – B**